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ON THE OSTEOLOGY AND SYSTEMATIC POSITION OF THE KINGFISHERS. (*HALCYONES.*)

R. W. SHUFELDT.

BY FAR one of the most useful contributions to the recent literature of ornithology is the work entitled "*A Hand-List of the Genera and Species of Birds*," by R. Bowdler Sharpe, Three volumes have already been issued, while the fourth and last one is now passing through the press.

This work presents us with a hand-list of the species and subspecies of the birds of the world brought fully up to date. The "Systematic Index" is practically a classification of the class Aves, and in fact is Sharpe's taxonomy of birds, and is therefore one of great value and worthy of our closest study. It also takes into consideration the fossil forms of birds, and the distribution of all forms. Among other Orders enumerated, we find in Volume II of the "Hand-List" Order XXIX,—the Coraciiformes, which is subdivided into fourteen suborders created to contain a great many different kinds, and very differently affined, birds. These are as follows:—(I) Steatornithes, (II) Podargi, (III) Leptosomati, (IV) Coraciæ, (V) Halcyones, (VI) Bucerotes, (VII) Upupæ, (VIII) Meropes, (IX) Momoti, (X) Todi, (XI) Caprimulgi, (XII) Cypseli, (XIII) Trochili, and (XIV) Colii. These suborders are duly divided into their families and other minor divisions. There is no intention of discussing in full this arrangement here, and the sequence of the suborders is given only to show the position assigned the Halcyones or the kingfishers, the group which is the subject of the present contribution. It is now more than thirty years since Sharpe published his famous monograph on the kingfishers, and it remains a classic in the literature of ornithology. In it the family Alcedinidæ was divided into nineteen genera, created to contain the 125 species described in the memoir. Of these a subfamily division was made, the line being drawn between the insectivorous Daceloninæ, with 14 genera and 84 species, and the piscivorous Alcedininæ, containing the balance of the group. Now as will be seen, the Halcyones are placed between the Coraciæ on the one hand, and the Bucerotes on the other, a long ways removed from such forms as the Galbulidæ or jacamars, the Buccones, and the ground cuckoos, (Geococcyx), birds that appear in widely separated and entirely different orders.

The Halcyones in the "Hand-List" we find still to be divided into the two subfamilies Alcedininæ and the Daceloninæ, the first still containing five genera, and the last by an increase of one, now containing fifteen. The number of species, however, have been increased from the 125 enumerated in 1870 to about 200, or in other words there have been about 75 species of Kingfishers described within the last thirty-two years. A knowledge of their anatomy, however, has by no means kept pace with this remarkable discovery of new and undescribed forms. The habits of the various kinds of kingfishers are described with greater or less detail in Sharpe's monograph, as well as the plumage and external characters, and as highly important as this is for an understanding of their affinities, it cannot be properly touched upon in this paper which deals with the osteology. North America is extremely poor in kingfishers, as we find but two species and a subspecies of the genus Ceryle (*C. alcyon*, *C. torquata*, *C. a. septentrionalis*), given in the last A. O. U. "Check-List." Australia, Africa, and the East Indies claim the greatest number of forms, but their distribution is extremely unequal, when taken as a whole, in so far as other countries are concerned.

In studying the osteology of such species as I have been able to obtain, I have taken special care to keep before me the geographical distribution of the family, the remarkable variations of the plumage, the beaks, and particularly the feet and other external structural characters; also similar data of the species representing other families of birds which avian anatomists from time to time have considered near relatives of the Halcyones. I have also had in mind, during my researches, the notes of the various species, their habits, and their nidology, all of which has been done in order to avoid any biased opinion I might otherwise arrive at on any particular point, where the osteology alone had come to influence me in the formation of an opinion.

It is eighteen years ago since I have been engaged with the osteology of the kingfishers, when I published a brief illustrated memoir on the "Osteology of Ceryle alcyon," which appeared in the *Journal of Anatomy*, (Vol. 18, London, 1884, pp. 279–294), and yet it can be said with great truth that we stand much in need of a thorough investigation of the general structure of the Halcyones. Avian taxonomers and anatomists are not unanimous on the systematic position of the kingfishers, and still less so on their relationships with other groups of birds.

Some thirty years ago Cunningham contributed a brief notice of some of the anatomical points of the kingfishers (*Proc. Zool. Soc.*, 1870, p. 280), and for various views upon the taxonomy of the Halcyones and their affinities one should consult Wallace, (*Ann. Nat. History*, ser. 2, Vol. 18, pp. 201–205.): Eyton (*Contrib. Ornithology*, 1850, p. 80.) : Huxley (*Proc. Zool. Soc.* 1867, p. 467.) : Coues ("*Key to N. Amer. Birds*," rev. ed. p. 469, 1884.) : Fürbringer (*Untersuchungen z. Morph. u Syst. der Vögel.* Amsterdam, 1888, pp. 1555–1567) : and the Monograph of Sharpe already cited.

According to Huxley's classification, the kingfishers (Alcedinidæ) belong to the Desmognathæ, they forming a family of a third group out of four of the division designated as the Coccygomorphæ. He associates with them the Bucerotidæ, Upupidæ, Meropidæ, Momotidæ, and the Coracidæ ; and he also believed that they approached the Pelargomorphæ in their structural characters.

Newton tells us with great truth that "it is to be regretted that hitherto no light has been shed by palæontologists on this interesting subject, for the only fossil referred to the neighborhood of the Family is the *Halcyornis toliapicus* of Owen (*Br. Foss. Mamm. and Birds*, p. 554) from the Eocene of Sheppey — the very specimen said to have been previously placed by König (*Icon. foss. sectiles*, Fig. 153) in the genus Larus. (*Dict. of Birds.* 1893, Pt. 2, pp. 488–489). In the same excellent work, and in the same article ("Kingfisher"), Newton further states that "the common Kingfisher of Europe is the representative of a well-marked family of birds, the *Alcedinidæ* or *Halcyonidæ* of ornithologists, which is considered by some authorities to be closely related to the *Bucerotidæ*; but the affinity can scarcely be said as yet to be proved; and to the present writer there seems to be at least some ground for believing that a nearer alliance is to be found in the *Galbulidæ*, *Momotidæ*, *Meropidæ*, and perhaps some other families — though all may possibly be discovered to belong to one and the same larger group."

The Halcyoniformes of Fürbringer form one of the suborders of his order Coraconithes, and he divides them into three groups (gens) *viz.*, the Halcyones, the Bucerotes, and the Meropes. In the first-named we find but one Family (*sensu latiori*), the Alcedinidæ, and this he divides into two others (*sensu strictiori*), the Halcyonidæ, and the Alcedinidæ. The Bucerotes contain the Bucerotidæ and the Upupidæ, while the Meropes contain only the single family Meropidæ.

In his *Manual of North American Birds* Robert Ridgway places the family Alcedinidæ, together with the Cuculidæ, Trogonidæ and Momotidæ in an Order Coccyges, but in differentiating the kingfishers gives a very slender array of characters, and no structural ones. (Phila. 1887, pp. 271–279.)

It is an interesting fact, although we have as yet but little knowledge of the habits of the jacamars (Galbulidæ), that at least some of the South American species secure their insect food after the manner of some of the Daceloninæ, and that further they make their nesting holes in marl-banks, thus agreeing with the nidification of some of the kingfishers (Ceryle).

Newton is not alone among ornithologists in the belief that the kingfishers are in some way more or less related to the jacamars (Galbulidæ) and the bee-eaters (Meropidæ). I believe it was the naturalist Lesson who named one genus of jacamars, Jacamaralcyon, and another Jacamerops.

It is perfectly safe to say at the present writing that there are no two avian classifiers who agree exactly on the question of the relationships of the kingfishers, while on the other hand, with others there exists the greatest possible variance in the matter of opinion on this subject. No two classifiers of birds would today agree as to the place of the Halcyones in the system, or would award them the same place in any scheme of classification. A unanimity of opinion can only be arrived at upon this point when the morphology and complete life-histories of all the forms are known, and have been compared and intercompared. As it is we are a long way from any such decision, and in fact we know very little of the anatomy of any of the kingfishers, the jacamars, the bee-eaters, the cuckoos, the trogans, the hornbills, the toucans, the hoopoes, and a dozen other families more or less related. This being the case, I must believe that any little contribution to the anatomy of any of the birds in question, will in time prove to be useful, and it is therefore with less hesitation that I bring forward here what little I have accomplished in the osteology of the Halcyones, not that I think that any part of it will completely settle any particular taxonomical point at issue, but that it may help to do so, when our knowledge in these matters becomes wider than it is at the present time.

In studying the osteology of the Halcyones I have carefully examined the skeletons of the following species of birds, and compared the characters they have presented with great thoroughness and detail.

1. *Ceryle alcyon*, belted kingfisher. North America.
2. *Ceryle a. septentrionalis*, texas kingfisher. Texas to Panama.
3. *Alcedo ispida*, Europe and many parts of the east.
4. *Geococcyx californianus*, road-runner. Mexico and parts of the western United States.
5. Various cuckoos of the genera Coccyzus, Cuculus, Crotophaga, and others.
6. *Dacelo gigas*, Australia (skull).
7. Several of the Meropidæ.
8. *Steatornis caripensis*, Northern S. Amer. and Trinidad.
9. Trogan (several species).
10. Bucerotidæ (several species).
11. *Nyctiornis amicta*, Borneo.

12. Galbulidæ.
13. Trochili, many species.
14. Cypseli, various species.
15. Momotus.

Also incidentally the representative of several other groups, as the woodpeckers, Caprimulgi, and the toucans.

I am indebted to the United States National Museum for the loan of some of the material used in the preparation of the present memoir, and to that institution my thanks are due, as they are to Mr. F. A. Lucas for the loan of the skeleton of *Alcedo ispida* from his own collection. For the trogan skeletons I have pleasure in thanking Dr. Sclater, late Secretary of the Zoölogical Society of London; and the skeletons of Geococcyx, Mr. Herbert Brown of Yuma, Arizona. A number of the swifts and goatsuckers were kindly sent me by Mr. Jno. H. Sage of Portland, Ct., Mr. Gerrit S. Miller, Jr., of the U. S. National Museum, and Dr. A. K. Fisher of the U. S. Dept. of Agriculture. Many humming-birds and much of the other material has been supplied me by Messers F. Stephens, H. K. Coale, Luther N. Rossiter, H. W. Henshaw, J. G. Parker, E. M. Hasbrouck, and others,— to each and all of whom I desire here to return my thanks. Not a few of these specimens, now types of descriptions, are in the collections of the British Museum, and the Royal College of Surgeons of England.

With this preliminary introduction I am now prepared to pass to the consideration of the comparative osteology of the kingfishers (Alcedinidæ) employing primarily for this purpose the skeletons of specimens of *Ceryle alcyon*, *Ceryle cabanisi* and *Alcedo ispida*. These I will not only endeavor to carefully intercompare, but in turn, compare them with the skeletons of the various species and material set forth in the above list.

In my conclusions I shall have something to say regarding the relationships of the Halcyones to other groups of birds.

The Skull. — By referring to the figures, herewith presented, illustrating the skeleton of our common kingfisher (*C. alcyon*), it will be noted that the superior osseous mandible of Ceryle is considerably longer than the remaining part of the skull, being in fact a three-sided pyramid, with a broad base and sharp-pointed apex. A very perfect cranio-facial hinge joins this structure to the cranium, and the tomial edges are sharp and slightly raised above the level of the nether aspect of this mandible. This skull is strongly desmognathous, and the rhinal chambers are quite filled in by the spongy mass of the bulky maxillo-palatines. Through this the parial subtubular narial passages run, and they terminate externally upon either side, as rather elongated, broadly spindle-shaped narial openings. Just to the rear of the posterior border of either one of these latter there is to be found a small circular foramen leading into the nasal passages just referred to, a character seen also in *C. cabanisi.* The external narial apertures are separated by a complete, rather thick septum narium, while in *Alcedo ispida* this partition is pierced by an oval foramen, at about its centre, and in this species the foramina described in the last sentence are absent.

The culmen, which forms one angle of this mandibular pyramid, is rounded; while the side that forms a good share of the roof of the mouth is flat, marked its entire length by a small, deep, median groove, that exhibits impressed venations branching from it upon either side. At the hinder end of this groove a pair of small foramina are seen (Fig. 2, *3*).

We find this mandible in Ceryle, although having a very solid appearance from being closed in on all sides as it is, to be extremely light, having internally very much the same structure as in the hornbills, only rather coarser.

There is one other feature we notice on the superior aspect of the mandible in Alcedo that is absent in Ceryle; this is a pretty-well marked groove, leading on either side from the anterior margin of the nostril back to the maxillary. It is shown in the drawing of this view of the skull here figured, from a specimen kindly lent me by Mr. F. A. Lucas of the United States National Museum (Fig. 1, *B*, *k*.).

Regarding the skull of Ceryle from above, we find the superior margins of the orbits sharp and regular, and separated from each other by the smooth, rather broad surface of the frontal region. This is slightly indented longitudinally by a shallow median groove that traverses the cranium from the transverse fronto-maxillary line, through the parietal portion. Here the surface is raised, on either side, into smooth rounded domes, that are less marked in *C. cabanisi*, and that are bounded behind by the prominent and projecting temporal fossæ. These latter are divided behind by a sharp median ridge (see Fig. 2). All these features, though present in Alcedo, are far less noticeable, while the median ridge tends to merge into the surrounding surfaces. This is completely effected in the skull of such a form, for instance, as Geococcyx, where the temporal fossæ are well separated, and the median ridge has become a broad surface, indistinguishable from the general superficies of the cranial vault. Holding a mid-position between these two conditions, we find an example in the skull of *Coccyzus americanus*, where the fossæ approach each other again.

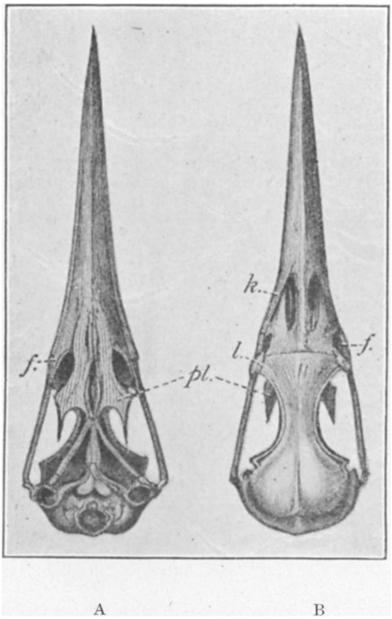

FIG. 1.— Superior (*A*) and inferior (*B*) views of the skull of *Alcedo ispida*; *l*, lacrymal; *pl*, palatine; *k*, inter-naso-maxillary groove on the mandible; and *f*, the maxillary. Natural size, after Shufeldt, *Jour. anat. Phys.* Vol. XVIII, 1884.

Ceryle has its occipito-basicranial region circumscribed, and its plane faces posteriorly and only slightly downwards, much as we see it in the skulls of some herons. The subcircular foramen magnum is of fair size, and the condyle comparatively small. Anterior to it the basitemporal space is limited, while the usual groups of foramina are to be seen upon either hand. There is also a groove leading up on either side of the foramen magnum, that terminates in a minute opening on the not very elevated supraoccipital prominence. The superior limiting margin of the occipital area in Ceryle is very sharp, while in Alcedo and Geococcyx, where the same characters first enumerated are present, this boundary is more rounded.

Viewing the skull of either *C. alcyon* or *C. cabanisi* laterally (Fig. 2), the unusually deep temporal fossa is again brought to our notice, occupying much of the space behind, terminating only at the superior margin of the large and very open ear cavity, and allowing but just enough surface for the lodgment of the head of the quadrate.

It has above it a flattened squamosal process, which is separated by a shallow concavity, still more anteriorly, from a feebly pronounced post-frontal projection. The ali-sphenoidal wall bulges forward in the form of an elevated dome, a feature characteristic also of Alcedo. Above, the thin and horizontal frontal affords the orbit an ample roof, this bone being carried forward to join with the extensive surface of the superior portion of the large *lacrymal.*

Viewed from above, this latter bone (Fig. 2) presents an oblong surface with slightly rounded angles. Its infero-anterior margin makes a close articulation with the nasal in front and the frontal above, rather more than one third being devoted to the first and the remainder to the latter bone. There is thrown down from beneath this superior oblong plate of the lacrymal another plate, the connection being a somewhat constricted neck, which forms the greater part of the anterior wall of the orbit. This plate is highly pneumatic, bulbous, and has a smooth surface with a light spongy interior; its shape is square, with rounded angles. Its outer portion below rests upon the horizontally expanded maxillary, while its inner and upper angle has wedged into it a small oblong process that is developed from the ethmoid: it is the pars plana. Above, they embrace a large subelliptical foramen, through which, in life, the nasal nerve and vessels pass. This inferior plate of the lacrymal is much larger than the superior, and is roughly placed at right angles to it.

Agreeing with *C. alcyon* and *C. cabanisi*, we find in *Alcedo ispida*, the form of the lacrymal and its articulations, substantially the same. It differs principally in being thicker from before, backwards, and the pars plana, which in this kingfisher is triangular, meets it about the middle of the inner border rather than at the superior and inner angle, as it does in Ceryle. In Geococcyx, the superior plate has moved down on the margin of the orbit nearer the maxillary, articulating almost exclusively with the nasal. This change nearly does away with any distinction between an inferior and superior plate, the two having run together in nearly the same plane.

The ethmoid here develops a very large pars plana, and the lacrymal is so twisted to pass down in front of it, the former really forming the anterior wall of the orbit. In *Coccyzus americanus*, the pars plana, is very extensive, and forms the entire interorbito-rhinal partition, while the lacrymal barely articulates with it, it being a light bone, having very much the form we found in Colinus.

One large vacuity is found in the interorbital septum in *Ceryle alcyon*, as shown in Figure 2. This has the appearance above of being divided in two, by a very narrow isthmus of bone, in Alcedo, but we find this deception due to the large foramina for the exit of the nasal nerves from the brain-case in this bird, these openings being exceedingly small in Ceryle.

To return to the latter we find that the quadrate presents little or nothing that is peculiar. Its orbital process is sharp and spine-like, projecting into the orbital space, though overshadowed by the bulging wall of the alisphenoid above. This process of the quadrate is remarkably stumpy and short in Alcedo, while it is broad and flat in Geococcyx and Coccyzus, where it almost rests against the posterior wall of the orbit.

Upon the inferior views of the skull of Ceryle, we observe the anterior extremities of the palatines to be broad, horizontally flattened and thin plates. They are separated from each other by an interval of about two millimeters, and merge beyond into the bony roof of the mouth already described. The interval between their anterior ends is continued backwards to a point well within the articulation of the heads that articulate with the pterygoids. Near their inner margins, posteriorly, quite a large foramen exists in each, which is a constant character. Opposite the pars plana of the ethmoid in Ceryle, each palatine throws up a triangular plate of bone to project freely into the rhinal space. The postero-external angles of these bones are truncate, a feeble spine being produced near the middle in *Ceryle alcyon*, a character better marked in *C. cabanisi* while in *Alcedo ispida* this character is developed as a spine-like spur, and is very conspicuous.

This feature is also present in *Dacelo gigas*, while in Merops the long and slender palatines are devoid of any postero-external elongations.[1]

In Ceryle the inner margins of the posterior moieties of the palatines always fuse together, and this fusion is carried back as far as the pterygoidal heads, which it includes.

In my specimens of *Coccyzus americanus* there are no spine-like projections from the postero-external angles of the palatines, but the angles in question are distinctly defined, differing in this respect from *Cuculus canorus*, where "the palatines are rounded off postero-externally" (Huxley). This is the case also in the skulls I have at hand of Geococcyx, but Huxley found them to be distinctly indicated in the specimens he examined of this bird, so here this character may vary perhaps with the age of the individual.

I find no vomer in any species of Ceryle, and in this it agrees with others of the group, for we know "in Kingfishers and hoopoes there is no vomer."[2] Geococcyx has a small vomer. Again, in our kingfishers, the pterygoids are very long and straight, their distal extremities having on their outer sides little horizontally flattened and projecting triangular processes, inconspicuously developed in some specimens, and entirely absent in Alcedo, Geococcyx, and Coccyzus. None of the forms just mentioned possess basi-pterygoid processes, and the pterygoids in the ground cuckoo are very short in comparison with the great length of the skull, being somewhat shorter than they are in Alcedo.

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[1] See Fig. 29, Huxley's "Classification of Birds, etc." *Proc. Zoöl. Soc.* 1867, p. 447.

[2] Parker, W. K. and Bettany, G. T. *Morphology of the Skull*, p. 264.

In Ceryle the maxillaries are long and broad, being horizontally expanded plates passing, on either side, into the extensively developed maxillo-palatine masses anteriorly, which nearly

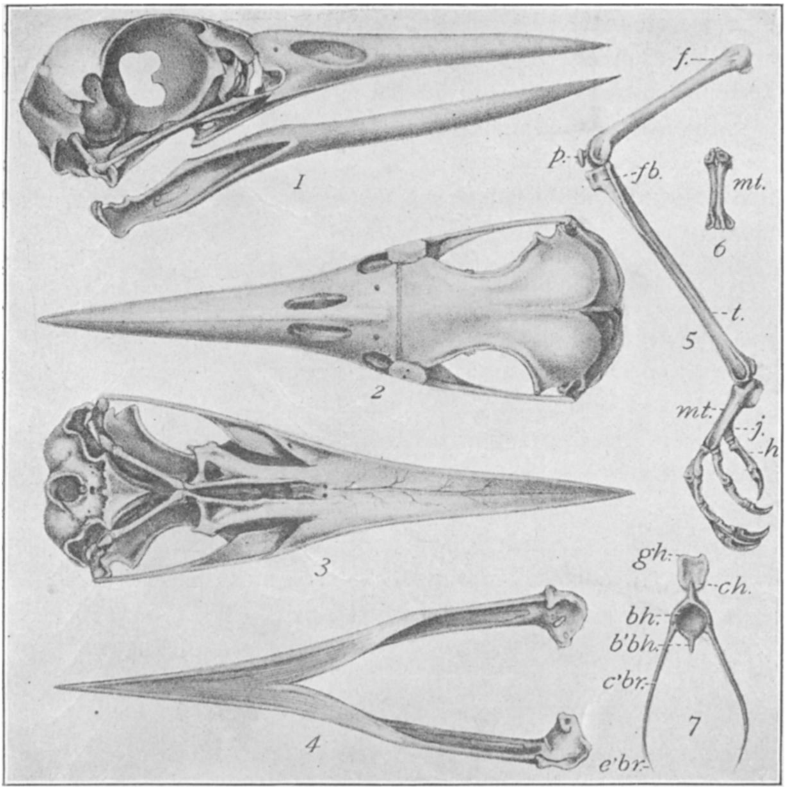

FIG. 2.—*1.*— Right lateral view of the skull and lower mandible of *Ceryle alcyon*: *l*, lacrymal; *nf*, nasal foramen; *ns*, nasal septum; *q*, quadrate; *pg*, pterygoid; *pl*, palatine; *m*, maxillary.—*2.* Superior view of the same skull, lower mandible removed.—*3.* Basal view of the same skull, lower mandible removed.—*4.* Superior view of the lower mandible of *Ceryle alcyon.*— *5.* Left pelvic limb of *Ceryle alcyon* : *f.* femur; *p*, patella; *fb*, fibula; *t*, tibio-tarsus; *j*, hallucial metatarsal; *h*, phalanx of hallux; *mt*, tarso-metatarsus. —*6.* The tarso-metatarsus, *mt*, in front view, from same limb.— *7.* The hyobranchial apparatus of *Ceryle alcyon*; viewed from above: *gh*, glossohyal; *ch*, cerato-hyal; *bh*, first basi-branchial; *b'bh*, second basi-branchial; *c. br*, cerato-branchial; *e. br*, epibranchial. All figures somewhat less than natural size, and reduced in the same proportion. After Shufeldt, *Jour. Anat. & Physiol.* Vol. 18, 1884.

fill up the forward part of the rhinal chamber (Fig. 2). In Alcedo this expansion is not particularly noticeable, while in other respects the arrangement of their parts is the same.

Alcedo also differs from the various species of Ceryle in the manner in which the quadrato-jugal bar articulates with the quadrate. In Ceryle it is received into an articulating socket on the outer side of the bone in question, while in Alcedo it meets it much more anteriorly, though somewhat laterally.

Passing to the base of the skull, again, we must note how small is the anterior aperture of the Eustachian tubes, and observe the sharpened lower border of the sphenoidal rostrum.

The form of the lower mandible is well shown in figures 1 and 4. It does not essentially differ in *Alcedo ispida*. Both of these birds sometimes have the ramal vacuity spanned across with a thin plate of bone, which may be pierced by a minute foramen. Sometimes in *C. alcyon* the ramal vacuity is nearly fitted in by this plate. Among the cuckoos this bone is very much more like the general form as we find it in the passerine types.

In Coccyzus a large ramal vacuity exists, and the internal angular processes are long and pointed, curving upwards, while rudimentary posterior angular processes here commence to make their appearance. In Ceryle the articular cups are deep; the mandible is pneumatic ; the inturned articular processes are short and blunt, while the hinder ones are truncated. The bone is V-shaped with a very deep symphysis.

Nothing worthy of particular note rewards our examination of the internal aspect of the brain-case. The usual sclerotal plates are present in the eyes, and proportionate in size with other parts. The arrangement of the ear-cell is very simple; the delicate bony tie beams found in its interior, in so many birds, is here replaced by solid bone, pierced only by the necessary openings.

The hyoid apparatus (Fig. 2, 7) departs very markedly from ordinary birds. This is seen principally in the broad first basibranchial (*bh*), with its slender, connate second basi-branchial (*b'bh*) reduced in this bird to a mere spine of no great length. The epi-branchials are very much shortened, and extremely delicate in structure, being tipped behind as usual with cartilage.

Behind, the glossohyal (*gh*) is broad and quadrilateral in outline, the cerato-hyals being scarcely discernible at its posterior and outer angles (*ch*).

The Axial Skeleton.— The vertebræ in Ceryle, when compared with many other birds of about the same size, are large, in comparison, with prominent processes. We find nothing to particularly distinguish the atlas. The plate closing in the neural canal of this segment above is oblong in outline, with a minute spine at each outer and posterior angle. The body is thick from before, backwards, so the shallow cup for the occipital condyle is never perforate, as it is in many birds. A large neural spine is found on the axis, and the diapophyses are elevated. Situated somewhat posteriorly, a neural spine, smaller than that of the axis, is found on the third vertebra, and this process diminishes in size as we proceed backwards, to disappear entirely on the ninth vertebra. The twelfth has a small one again, becomes larger still in the thirteenth, and in the next of the series appears very much like the elevated quadrate plates as seen in the dorsals. In the third vertebra the foramen found in the plate between the pre- and postzygapophyses, as a common avian characteristic, is here sometimes scarcely perceptible. But in this vertebra two other features arise — the cervical extremity of the vertebral canal, with minute parapophyses projecting from it on either side, and, secondly, the appearance of an hypapophysis beneath. In some of the leading cervical vertebræ after the third, usually the fourth, fifth and sixth, there is a bridge of bone, on either side, connecting the posterior margin of a parapophysis with the antero-external base of the corresponding postzygapophysis. This bridge becomes absorbed behind, in the sixth and may be in the seventh and eighth vertebræ, and then projects from the parapophysis simply as a spine-like process. The vertebral canal persists through the cervical chain to include the twelfth vertebra; in the thirteenth it is closed in by a very delicate little rib, consisting of but scarcely anything more than head, neck and tubercle. In the fourth vertebra the hypapophysis is but feebly developed, while the parapophyses are much stronger; these latter disappear in the twelfth vertebra. The carotid canal traverses the inferior aspects of the centre of the fifth to the ninth vertebra inclusive; while in the tenth, eleventh and twelfth a median single plate reproduces the hypapophysis once more. This process is three-pronged in the thirteenth; bifurcate, with nearly horizontal limbs, in the fourteenth, which latter decrease in size in the next, although the process lengthens, — and thus it continues, as a rule, throughout the dorsal series, being shorter only upon the last two. In some specimens of *C. alcyon* I have seen this hypapophysis quite rudimentary upon the last dorsal vertebra, and in a specimen of *C. cabanisi* (U. S. National Museum) I find these spines present, though they are not very long, upon the two leading vertebræ of the sacrum. There is also at my hand a disarticulated skeleton of *C. alcyon*, and in these two individuals, this one and the aforesaid skeleton of *C. cabanisi*, I find after careful count, rather a remarkable difference in their vertebræ. In the skeleton of *C. alcyon* there are *nineteen* free vertebræ from the occiput to the pelvis, whereas in the skeleton of *C. cabanisi*, there are but *eighteen*. Again, in the latter we find the first pair of free riblets, (cervical ribs) on the *twelfth* vertebra; a stronger pair on the thirteenth; and a free pair again on the fourteenth; the last ones have epipleural appendages upon them. Now in the skeleton of *C. alcyon*, the first free cervical riblets occur upon the *thirteenth* vertebra; a stronger pair is found upon the fourteenth; and finally, a free pair, with epipleural appendages, upon the fifteenth. In my paper upon the osteology of *C. alcyon* in the *Journal of Anatomy* (London, 1884) I see that the specimen whose skeleton I there describe, had the same arrangement as the skeleton of the individual now before me belonging to the collections of the U. S. National Museum.

That there is a variability in the number of vertebræ appears from what follows; — for I find that in my paper, first mentioned, I say of the dorsal series of ribs and vertebræ, in *C. alcyon* that "The four dorsal vertebræ, with their ribs connecting with the sternum, have nothing very peculiar to mark them. They freely articulate with each other, and develop stumpy metapophyses on their transverse processes. The unciform projections are not anchylosed with the ribs. Two pairs of ribs are suspended from beneath the ilia, belonging to the antecedent vertebræ of the so-called "sacrum." The first pair have small unciform processes, their hæmapophyses articulating with these bones on the last dorsals in the usual manner; the last pair, which are very delicate in structure, vary exceedingly in length, and terminate in free extremities." Now the just-quoted description does not tally with what I find in the skeleton of *C. alcyon* from the U. S. National Museum, for in the first place in the sternum of that individual there are *four* articular facettes upon the *right* costal border and but *three* upon the *left*. The fault here, however, or this discrepancy seems to be due to some difference in arrangement at the fore end of the series, as the *left* costal process is longer, and has a suspicious looking spine *anchylosed* to it, at about the point where the leading costal rib ought to have had its facet. The *total* number of ribs in these two specimens of *C. alcyon* may, however, have been the same, while a difference only existed as to the number that connected with the sternum by costal ribs. This will not apply, though, to what we find in *C. cabanisi*, for here, although there are *four* dorsal pairs of ribs, supplied by the 15th, 16th, 17th and 18th vertebræ, only the three leading pairs connect with the sternum by means of hæmapophyses; the last pair failing thus to connect. Then, finally, there is but one pair of "sacral ribs," and their hæmapophyses are still shorter than the pair on the last dorsal ribs, and these sacral ribs are likewise without epipleural appendages, being the only pair that do lack them in this species. The arrangement of the ribs in birds cannot always be relied upon nor even that the same species always have the same number; but I cannot well account for the difference in the number of the cervico-dorsal vertebræ in these two kingfishers. The method of anchylosis of the pelvic bones with the sacrum sometimes has something to do with it, but apparently not here, for as near as I can count in the pelves of these adult birds, there appear to be *twelve* vertebræ in the pelvic sacrum of *C. alcyon*, and but *eleven* in *C. cabanisi*. This evidently does not help, for to satisfactorily account for the difference in question, the count should stand the other way.

Aside from the number of vertebræ in the pelvic sacrum, however, the pelves in these two species of kingfishers are very much alike. In both, the pelvis is broad and shallow. The ilia are widely separated from each other throughout their extent, and, anteriorly, the sacral crista is low and inconspicuous. Interdiapophysial parial foramina occur the entire length of the pelvis, being very small, or sometimes only closed in at an area constituting the central portion of the bone. Individual specimens differ much in this respect, they being nearly absent in some (see Fig. 3). The superior surface of either ilium, anteriorly, is concaved, not extensive, looks upwards and outwards, and is especially characterized by a sharp, backward-turned process upon its outer margin. Viewed laterally, the pelvis appears very shallow; the pubis being a curved, slender rod of nearly uniform calibre that does not come in contact with the ischium above, for its entire length. It projects somewhat posteriorly. Upon this aspect a notch, triangular in outline, is seen to exist between ischium and ilium at their posterior borders. Antitro-

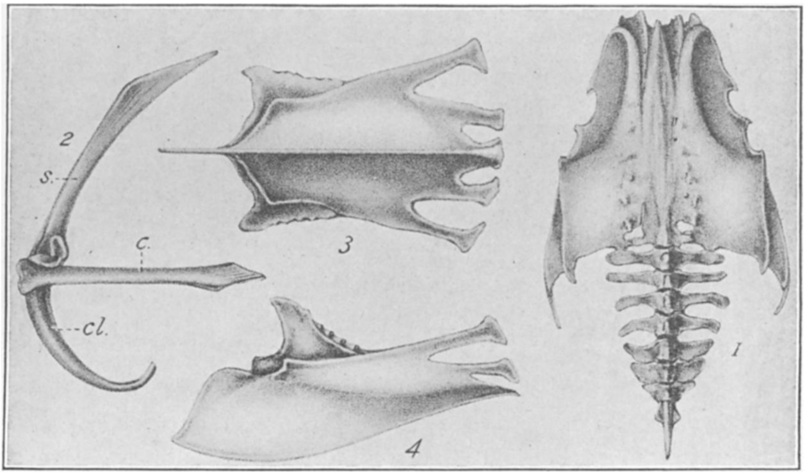

Fig. 3 — *1.* — Pelvis and coccygeal vertebræ seen from above in *Ceryle alcyon.* — *2.* Left lateral view of the shoulder-girdle of *Ceryle alcyon*; bones articulated as in life; s, scapula; c, coracoid; cl, clavicle. — *3.* Lower view of sternum of *Ceryle alcyon*; and shows very well how far the carina in the curiously shaped sternum of this Kingfisher projects beyond the body of the bone. — *4.* Left lateral view of the sternum of *Ceryle alcyon.* Figures all drawn by the author, natural size after Shufeldt, *Jour. Anat. & Physiol.*, Vol. 18, 1884.

chanter is small, but the foraminal apertures, the acetabulum, the obturator and ischiadic apertures, seen upon this aspect, are of an average size.

Seen upon ventral aspect, we are to note, that usually but a single pair of parapophyses are sent out as supporting braces opposite the acetabulæ. The sacrum on this aspect exhibits, along its middle portion, a medio-longitudinal groove that is very striking even upon superficial examination; the centrum of the anterior sacral vertebra is very deep and sharp. Specimens of *C. alcyon* show *three* anterior sacral vertebræ that throw out lateral processes against the nether aspects of the iliac walls. *C. cabanisi* shows *four*. The pelvic basin is broad and capacious in both these kingfishers, being more so in the former species than it is in the latter.

The tail-vertebræ are seven in number, not including the rather small pygostyle. The three anterior ones usually have long and slender diapophyses, while these processes in the last four are broad and become gradually shorter as we proceed posteriorly. We also note that the last three caudal vertebræ develop bifurcated hypapophyses below, a character likewise enjoyed by the pygostyle.

The sternum in the representatives of the genus Ceryle is rather a curiously formed bone, and not only differently shaped from the sterna of ordinary birds, but differs to some extent among the several species. So far as I know, it is invariably four-notched in this group of kingfishers, the xiphoidal prolongations being dilated at their hinder ends, more especially the outer ones. Four facets for the hæmapophyses of the dorsal ribs are found on the superior aspect of each costal border, and beyond the anterior ones prominent costal processes arise.[1]

The sternal carina is somewhat shallow behind, gradually becoming much broader in front, where it protrudes considerably beyond the body of the bone (see Fig. 3). In *C. alcyon* its anterior margin is straight, while in *C. cabanisi* it is markedly concaved; and in both species it extends the full length of the sternum. Another difference is seen in the manubrial process, for in *C. alcyon* it may be said to be almost entirely aborted, whereas in *C. cabanisi* the supero-anterior angle of the projecting keel rears into quite a respectable manubrium.

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[1] I have already stated that in one sternum of *C. alcyon* examined, there were but three of these facets on the left costal border, and the usual four upon the right.

The grooves for the coracoids do not meet in the median plane by at least a millimeter or more in the larger species, while we often find a pneumatic foramen present immediately in front, upon the antero-superior edge of the projecting sternal keel. Both these kingfishers, too, seem to possess a small, circular foramen of this character, in the median line, on the thoracic aspect of the body, just within the anterior coracoidal border. Our belted kingfisher also has minute apertures of this nature at the base of the interhæmapophysial pits along either costal border.[1]

Coming next to consider the bones of the shoulder girdle (Fig. 3) we find the scapula in *C. alcyon* to be rather broad, of nearly uniform width throughout, being obliquely truncated from within outwards for its posterior third. It has a conspicuous process, which, when the bones of this arch are articulated, extends in the direction of the head of the corresponding coracoid, having the furcula resting against its mesial aspect. *Ceryle cabanisi* has comparatively a narrower scapula, and its posterior end is more distinctly bent outwards. In it the coracoid process, just described, does not reach the coracoid when the bones are assembled *in situ*. The coracoid is considerably dilated at its sternal end, with raised facet there on its posterior aspect for sternal articulation. Its shaft is straight, not stout, subcylindrical in form, and rather long. At its anterior end we note a large glenoidal facet, and the usual inwardly-crooked, tuberous head. A spiculiform, clavicular process, is to be seen at some considerable distance below this, upon the mesial aspect of the shaft. This is equally well-marked in *C. cabanisi*, a species having a coracoid after the pattern of that bone in the typical picivorous kingfishers.

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[1] Before passing to the consideration of the shoulder girdle, and closing my description of the vertebral column and its attached bones, it is well to note an interesting point in the vertebræ of Ceryle which I believe was first demonstrated by W. K. Parker in his paper "On the Osteology of *Steatornis caripensis*." (*Proc. Zool. Soc.* of Lond. Apr. 2, 1889; p. 175). In comparing the skeleton of Steatornis with our kingfisher (a specimen of which I had sent him), Parker says "In a New-World Kingfisher (*Ceryle alcyon*) the hinder dorsal centra make a great approach to those of Steatornis, without, however, being opisthocœlous." And again upon the same page. "The *sacral vertebræ* [of Steatornis] and the whole pelvis are very much like those of *Ceryle alcyon*,— the Kingfisher whose dorsals show a tendency to the opisthocœlous character, and have deep, concave-sided dorsal centra, with long, basally-dilated, inferior spines."

I have personally made this same comparison, and can confirm the points above noted by Parker, especially in the pelves of these birds, is the resemblance striking. Steatornis, however, lacks the peculiar process upon the outer free margin of either ilium, seen in the kingfisher, and upon ventral aspect it would appear that the parapophyses are not increased in size, length and strength, to act as braces opposite the acetabulæ, as they are in Ceryle. For the remainder of the skeleton in these two forms, the resemblance ends entirely, beyond the points just cited.

Our belted kingfisher has an os furcula of the broad, — very broad U-shaped model — without a semblance of a hypocleidium. The bone is slender below, but the clavicular limbs gradually become broad, and much compressed laterally, as we proceed in the direction of either head. So that, viewed as a whole, either clavicular limb may be said to be almost blade-like, with the free end, when articulated *in situ*, reaching back along the antero-mesial aspect of the corresponding scapular for some little distance. *Ceryle cabanisi* is peculiar in having a process developed upon the superior margin of either clavicular head, which, passing upwards and backwards, articulates with the tuberous head of the corresponding coracoid at a point situated at its antero-mesial aspect. I find no os humero-scapulare in any of these birds.[1]

The Appendicular Skeleton.— In the pectoral limb the humerus is the only bone possessed of pneumaticity; — the pneumatic foramen being single, very open, and fills the entire base of the fossa. Its surrounding margins in *C. cabanisi* are thickened, and the fossa is markedly shallow. Proportionately, this bone is very long, — being but two thirteenths shorter than the bones of the antibrachium. Its radial crest is but moderately developed, and a deep valley is sculpt 'twixt ulnar tuberosity and humeral head. In other respects this bone presents the usual characters found among birds generally.

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[1] With respect to the method of articulation of the os furcula in *C. alcyon*, I find that in my above-quoted paper upon the osteology of that species I said that "In the articulated skeleton (Army Medical Museum, Washington, Section Comparative Anatomy, No. 155) it rests against the anterior border of the sternal keel at the junction of the middle and lower third."

This must be taken with caution, as it may not be invariably the case, and the skeletons in the institution referred to, are by no means to be relied upon. In *C. cabanisi* it does not thus rest upon the anterior carinal border.

The osseous tubercles for the quill-butts of the secondaries, found in many of the class along the shaft of the ulna, are here absent or very faintly perceptible in some specimens. Both bones of the antibrachium in the well-developed limb of these kingfishers are as we usually find them in ordinary birds. *C. alcyon* upon the superior aspect of the distal end of the radius, exhibits a single, deep groove for the guidance of tendons. The two carpal segments are well apart from each other, thus affording quite an extensive share of the head of the metacarpus for articular surface for the ulna. I find no small sesamoids, either at the wrist or at the elbow. The index metacarpal, the main shaft of the carpo-metacarpus, develops at the proximal extremity of the shaft, the palmar aspect, the flattened process which is seen in other groups of birds. It nearly reaches across to the border of the adjacent middle metacarpal, and this latter bone is distally longer than the metacarpal of the index, projecting slightly beyond it. The expanded portion of the proximal phalanx of index finger is non-perforated and well-developed.

One phalanx is allotted to pollex digit, two to index, and one to medius, claws and spurs being absent in the manus of Ceryle.

Formerly, I believed the pelvic limb in the kingfishers was entirely non-pneumatic, but by examining far more extensive material, I am convinced that the femur may be pneumatic in many individuals. The National Museum specimen (No. 18749) of *C. alcyon* is peculiar in this respect, for the right femur undoubtedly enjoys this condition, whereas the fellow of the opposite would, I think, be taken for a non-pneumatic bone. For its remaining characters we are to note, that although the trochanter projects somewhat anteriorly, it does not rise above the summit of the shaft. This latter is straight and cylindrical, being but very feebly marked by ridges or lines for muscular attachment. An ordinary avian patella is present.

On the proximal and anterior aspect of the tibio-tarsus the pro- and ectocnemial ridges are but feebly produced: they are best marked in *C. cabanisi*. An evident feebleness stamps the bones of the leg, that is when we came to compare them in size with other long bones of the skeleton. Kingfishers having weak pelvic limbs, we naturally find the skeleton of the parts likewise weak. Nowhere is this better seen in the limb of this bird, or birds of this group, than in the tarso-metatarsus and foot-skeleton. At the distal extremity of the tibio-tarsus of *C. alcyon* we find the antero-osseous bridge for the confinement of certain tendons to be situated very low on the shaft, indeed, it occurs immediately above the rather prominent condyles.

The fibula has but a slender spine of bone below the fibular ridge of the tibio-tarsus, and in some specimens I find even this missing. When this latter condition exists, *C. alcyon* has as short a fibula as any bird of its size, with which I am at present acquainted.

The tarso-metatarsus is less than a third as long as the shaft of the tibia (Fig. 6), the rather large free metatarsal for hallux thus being compelled to take a position in articulation very near the middle of the shaft of this bone. The "hypotarsus" is large in proportion, and exhibits a median groove, posteriorly, for the passage of tendons, and immediately anterior to it a single cylindrical perforation for the same purpose.[1] Distally, the tarso-metatarsus, has three well-developed trochleæ, either of the lateral ones being larger than the bigger one in the middle. The foramen for the anterior tibial artery is present, while at the proximal end of this bone in front we note a small protuberance for the insertion of the tibialis anticus muscle, as well as two small antero-posterior perforating foramina, placed close to each other side by side.

The digits of the foot possess the normal number of phalanges (2, 3, 4, 5), as they occur in the class. The basal joint of hallux is somewhat laterally expanded at its proximal end. With respect to the joints of the other toes, the three anterior ones, we note that the proximal joints have an articulatory movement nearly in the same subhorizontal plane, while careful examination of the opposed surfaces of the bones composing the outer and middle toes, show the effect of their being so long strapped together in a common podothecal sheath, in the evident compression of the ridges and elevations usually found on these phalangeal bones in avian feet where the digits are free.

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[1] This corrects a statement I made on this head in my paper "On the Osteology of *Ceryle alcyon*, quoted above. There are a few other slight inaccuracies I have taken the opportunity to correct in the same manner.

SYNOPSIS OF THE PRINCIPAL OSTEOLOGICAL CHARACTERS OF THE GENUS CERYLE OF THE FAMILY OF THE KINGFISHERS.

1. Superior mandible once and a half as long again as the cranium; tapering and of a pyramidal form, flat upon its under side.
2. Septum narium complete.
3. Cranio-facial hinge quite movable (this is especially the case in the dried skull, after the quadrate and lacrymals have been removed).
4. Lacrymal large, with a superior and inferior portion.
5. Pars plana very small.
6. Large vacuity in interorbital septum.
7. Maxillaries very broad, horizontally flattened plates.
8. Maxillo-palatines large, subspongy, fused in middle line, nearly filling post-rhinal chamber.
9. Palatines broad, horizontal, with the postpalatine parts fused together in the middle line. A large foramen pierces either postpalatine.
10. Pterygoids long and straight.
11. Crotaphyte fossæ deeply sculpt, and only separated by a crest posteriorly.
12. Lower margin of sphenoidal rostrum sharp.
13. Lower mandible V-shaped; long deep symphysis; articular cups deep, truncated behind, with stumpy inturned processes.
14. Hyoidean arches peculiar, with very broad basibranchial and cerato-hyal parts.
15. Nineteen cervico-dorsal vertebræ in *C. alcyon*, and only

eighteen in *C. cabanisi*, with a variable arrangement of the ribs.[1]

16. Vertebræ comparatively large; long hypapophysial processes characterize the ultimate cervicals and the dorsals. Centra of dorsal region laterally compressed, subopisthocœlous (Parker). Pneumatic. Neural canal large in mid-division. Carotid-hypapophysial canal open. Seven caudal vertebræ and a pygostyle.
17. Pelvis broad and shallow; ilia widely separated from sacral crista, with a peculiar process on the outer free margin of either bone. Postpubic element long and slender, projects posteriorly, and is not in contact with ischium above. One pair of vertebral parapophyses thrown out as braces opposite the acetabulæ.
18. Sternum 4-notched behind, with carina projecting in front. Manubrium either entirely aborted or much reduced. Pneumatic.
19. Os furcula broadly U-shaped, slender below, broad above, where in *C. cabanisi* a peculiar process is developed extending to head of coracoid on either side. Coracoids long, and moderately slender. Scapula with conspicuous coraco-clavicular process, the blade of the bone being narrow, longly truncated behind, and in *C. cabanisi* turned outwards for its posterior third.
20. Pectoral limb well-developed: humerus pneumatic: long. Process present on proximal end of index metacarpal, palmar aspect. Blade of proximal phalanx of index digit entire.
21. Lower part of pelvic limb feebly developed. Femur may or may not be pneumatic. Patella present. Fibula weak. Tarso-metatarsus very short, with its hypotarsus once pierced and grooved for tendons. Podal joints run 2, 3, 4, 5 respectively, feeble, and in the anterior toes somewhat laterally compressed.

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[1] This character needs further investigation, and it should be either confirmed or disproved.

NEGATIVE CHARACTERS.

(Ceryle.)

1. Vomer absent.
2. No basipterygoid processes.
3. No hypocleidium on os furcula.
4. Os humero-scapulare absent.
5. No prepubis on pelvis.
6. Claws not present on digits of manus (?)
7. Aside from patellæ, sesamoids not found in the limbs.

FURTHER OSTEOLOGICAL COMPARISONS, WITH NOTES ON THE POSITION OF THE KINGFISHERS.

My opinion upon the systematic position of the kingfishers is but a tentative one, for I have not examined all the material I could wish in order that I might render it more positive. There are many forms of kingfishers in the world, and they vary much among themselves in their organizations. The anatomy of these various species should be fully comprehended, and with this knowledge at our command we should fully investigate the structural economy of many forms of birds that we now suspect of being alcedine affines,—and it will only be when this is done that we will gain any correct idea of the subject.

As the present memoir shows, I have carefully looked into the skeletology of our two species of Ceryle. Further, I have examined in connection with other extensive materials a skeleton of *Alcedo ispida*, and a skull of *Dacelo gigas*. Skeletons of Coccyzus, Crotophaga, and Geococcyx have also been thoroughly compared, and I have compared skeletons of a jacamar, of Diplopterus, and one of the Meropidæ from Borneo, *viz.*:—*Nyctiornis amictus*. Also, I have studied some of the skeletons of various Bucerotidæ and the Trogones, as stated.

We find the skeletons of the extremes of the insectivorous Daceloninæ and the piscivorous Alcedininæ to differ considerably in their characters, and I am of the opinion that it will be through a study of the osteology of the Daceloninæ that we will eventually come to a knowledge of the kinships of the kingfishers with other groups of birds.

To me, it is not difficult to see the reason for Huxley's remarks when he said "*Alcedo* and *Dacelo* repeat the structure observed in *Geococcyx*, with minor modifications, and that "the *Alcedinidæ* [approach] the Pelargomorphæ" (*Proc. Zool. Soc.* 1867, pp. 447 and 467).[1]

Already I have committed myself to the belief that the Halcyones are most nearly related to the Galbulidæ. Still, I think so, but I likewise think that the osteological resemblances will best be seen when we come to compare the skeletons of certain jacamars with the more aberrant Daceloninæ.

The specimen of Jacamar (sp. ?) now at my hand shows in its skull some characters that agree pretty well with the corresponding ones in the skull of *Ceryle cabanisi*, but as a whole the Jacamar's skull agrees equally well, and in some respects better, with the skull of Geococcyx. It differs from both in having an entire orbital septum ; in having a remarkably long post-frontal process, with a complete abortion of the squamosal process ; and in the supraorbital prominence being so conspicuous. Its pars plana and lacrymal most nearly approach Geococcyx, but its lacrymal is peculiar in the great definition of its external notch.

The osseous mandibles are most like the kingfisher's, while its palatines and its maxillo-palatines again remind us most of the same bones in Geococcyx.

It seems to lack a vomer, and this would again suggest Ceryle or perhaps some other more nearly related Kingfisher.[2]

With respect to the sternum, we remember that the fore-part of the carina in *Ceryle alcyon* and *Ceryle cabanisi* differ considerably in their form. Now, the fore-part of the sternum, the carina of the same, and the costal processes in this Jacamar, more nearly agree with what we see in these parts in *C. cabanisi* than do the same parts agree between the two kingfishers just mentioned. But in the jacamar the two notches upon either side of the keel are notably profound, and the xiphoidal prolongations very slender ; the inner ones not being in the least dilated at their hinder tips, while very handsome dilations characterize the ends of the outer pair. Now to make the sternum of *C. cabanisi* agree with the sternum of the Jacamar, we would simply have to deepen its notches to a similar extent, and the two bones would then be very considerably alike. Again the fore-part of the pelvis in the jacamar is quite after the order of the kingfisher, but the resemblance is lost when we see in the former how peculiarly the ilia and ischia are produced behind; but here, too, this appears to be but an exaggeration of what we really see in *Ceryle alcyon.* Aside from the zygodactyle feet of the jacamar, we could easily select some very good characters, that seem to indicate that in the remainder of the trunk skeleton, and the skeleton of the limbs of this bird there is much more than a mere resemblance to the corresponding parts in the skeletons of our two North American kingfishers.

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[1] I can still see this, notwithstanding the fact that the postero-external angles of the palatines in Geococcyx are *not* produced as processes, as they are in Alcedo and Dacelo, and as Huxley thought they were.

[2] There are some points about the skull of this Jacamar that call to my mind the skull of certain of the Trochili.

When we come to compare our skeleton of *Nyctiornis amicta* as representing the Meropidæ with the skeletons of the two species of Ceryle we have under consideration, we meet with still other characters that suggest inter-relationship for these two families, while Nyctiornis has some peculiar characters of its own. In principle, the arrangement of the bones of the palatal aspect of the skull, agree in Geococcyx, Ceryle and Nyctiornis, and I may say the resemblances are distributed with the most perplexing singularity.

On the whole the superior osseous mandible in Nyctiornis is more like what we see in Geococcyx than in either of our kingfishers, while the lower jaw possesses characters common to both, and is peculiar in not having even the vestige of a ramal vacuity, wherein it disagrees with both.

The lacrymal in Nyctiornis is very similar to that bone as it occurs in Geococcyx, but it is narrower, and not quite so tuberous ; the exceedingly small pars plana, however, agrees with Ceryle, and leaves in this bee-eater a great vacuity between lacrymal and pars plana, which opens into the rhinal chamber. Its interorbital septum is thick and practically entire ; this agrees with the Jacamar, and differs with both the cuckoo and the kingfisher. The form of the occipital region of the cranium and the deep and sharply-defined crotophyte fossæ of Nyctiornis agree in many respects with Ceryle, but when we come to compare the pterygoids and quadrates of our Bornean bee-eater with those bones as they occur in *Ceryle cabanisi*, we are confronted with decided differences. In the kingfisher the orbital process of a quadrate is almost a hair-like process, while it is broad and strong in Nyctiornis. Again, in the kingfisher the proximal end of the pterygoid articulates with the mesial aspect of the inner mandibular facet of the quadrate ; in Nyctiornis it articulates with a facet situated directly between the orbital process of the quadrate and its mandibular condyle. The mandibular sesamoid in the bee-eater is unusually large, is moulded upon the quadrate, and articulates with a special facet upon the angular extremity of the jaw.

The post-palatines of Nyctiornis fuse together in the middle line, and with the small, rod-like vomer of this bird, while the postero-external angles of the palatines are angulated without possessing a very distinct process. The maxillo-palatines are large and co-ossified across the middle space as in Geococcyx, and they practically agree in these two species. At the lateral aspect of the skull in the bee-eater we observe the post-frontal and squamosal processes to be rather small, and the zygomatic bar transversely compressed, and vertically rather broad. We may add here that the skeleton of the hyoidean arches of the kingfishers is peculiar, and is quite different from what we see in the Meropidæ. I have not examined it in the jacamars.

Passing to the remainder of the skeleton we find many points of agreement between *C. cabanisi* and Nyctiornis. Their vertebral columns and ribs are essentially very much alike, and this is strikingly the case with the pelves of these two birds. In their limbs and shoulder-girdles they also agree very well indeed, but we find in Nyctiornis, on the other hand, a most remarkable sternum. This bone has a manubrial process quite like what we see in the sternum of *C. cabanisi*, but it differs in having an osseous mesial bridge thrown across from its posterior aspect to the anterior border of the body of the sternum, and this bridge, above, develops two lateral processes, one upon either side, while the coracoidal grooves are below it. Posteriorly, this sternum is even more peculiar, for externally its xiphoidal portion shows two very deep lateral notches, with slender processes to their outer sides which have large dilated hinder ends, while internally, that is upon either side of the sternal keel, we find an elongated, sub-elliptical fenestra. Either one of these fenestra have the appearance of being formed by the hinder end of what would have been the internal xiphoidal process, fusing with the posterior point of the mid-xiphoidal prolongation.

There are two points, that should be mentioned, perhaps, in the shoulder-girdle of Nyctiornis before closing my brief comparative remarks upon its skeleton, and one is the conspicuous expansion of the sternal end of either coracoid; and the other, the fact that the outer aspect of either clavicular head has a modified, jutting shoulder upon it for articulation with the anterior aspect of the tuberous head of the corresponding coracoid.

There is evidently a hetero-kinship among Coccyzes, Halcyones, Meropidæ, Galbulidæ and undoubtedly other groups of birds, but we will know little of the nearness or the remoteness of these several affinities until the entire morphology and life histories of the several groups are worked out.